The Past and Future of Computing in Geotechnical Engineering: The Inside-out View

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Geo Institute Atlanta Congress
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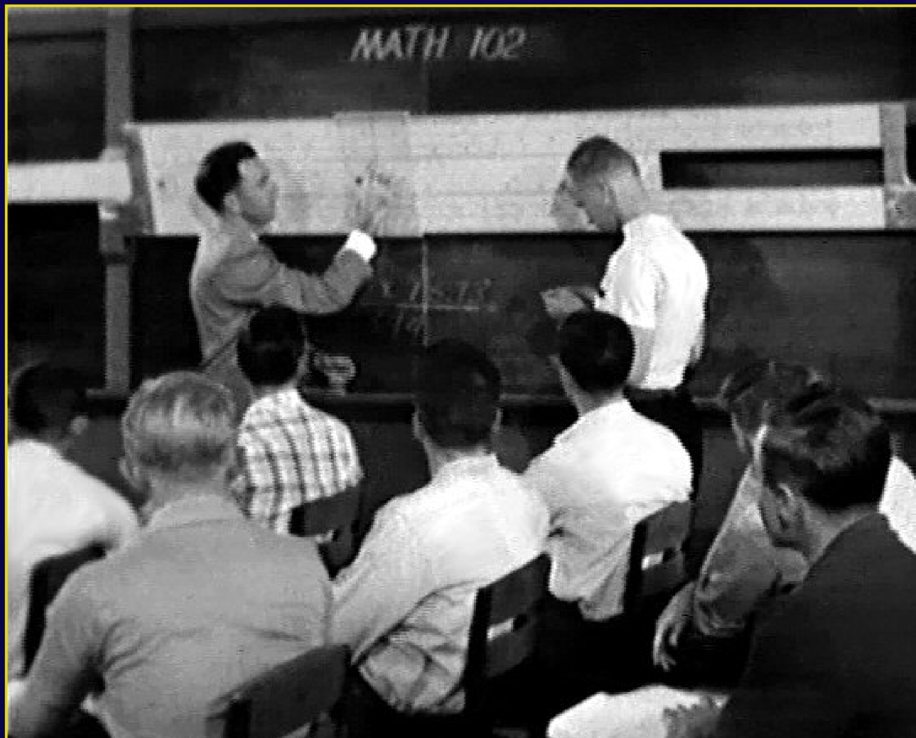
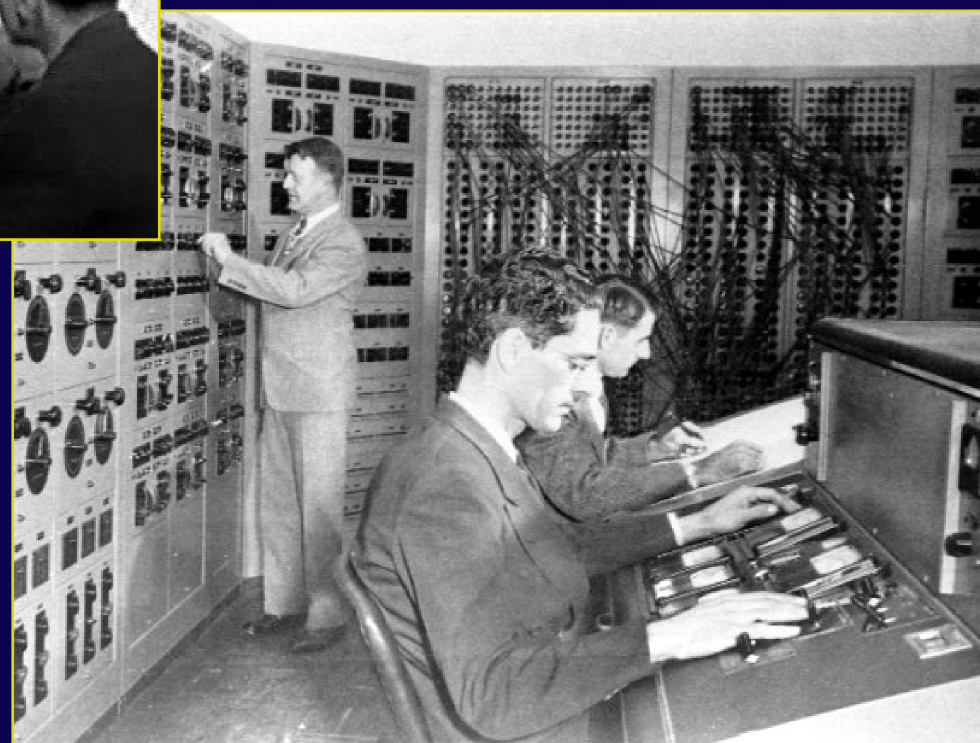


Learning the mysteries of the slide rule in Math 102.



This AC network calculator was state-of-the-art in 1950.

The Facit 10-key mechanical calculator was powered by hand cranks.

The first battery-powered calculator, the Sharp QT-8B "micro Compet," offered an 8 digit display that used green vacuum fluorescent tubes.

Vintage Calculators Web Museum

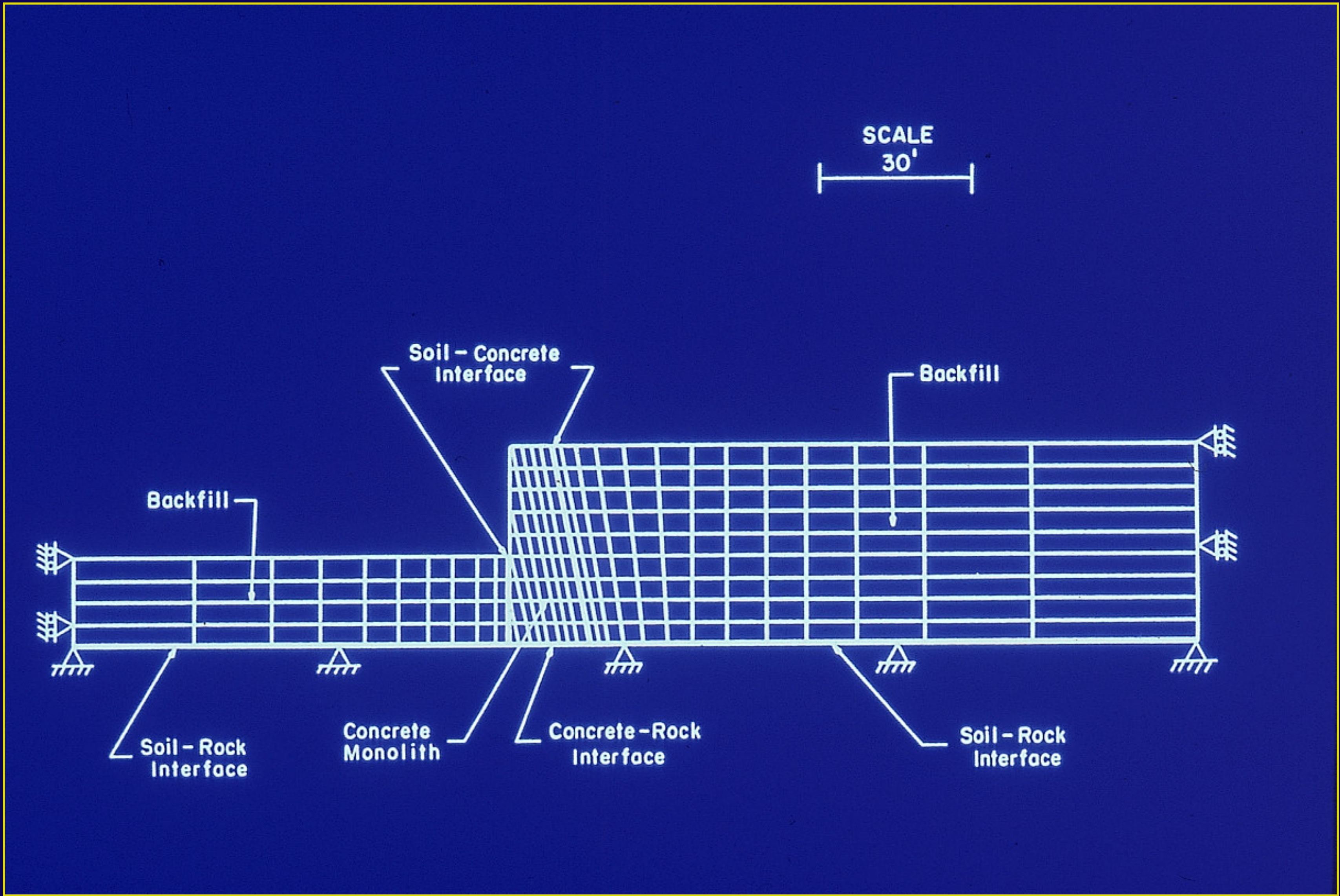
Visible storage: early computers

Punch cards held the programs.

The 1964 IBM Model 083 Card Sorter could sort 1,000 cards a minute.

Computerhistory.org

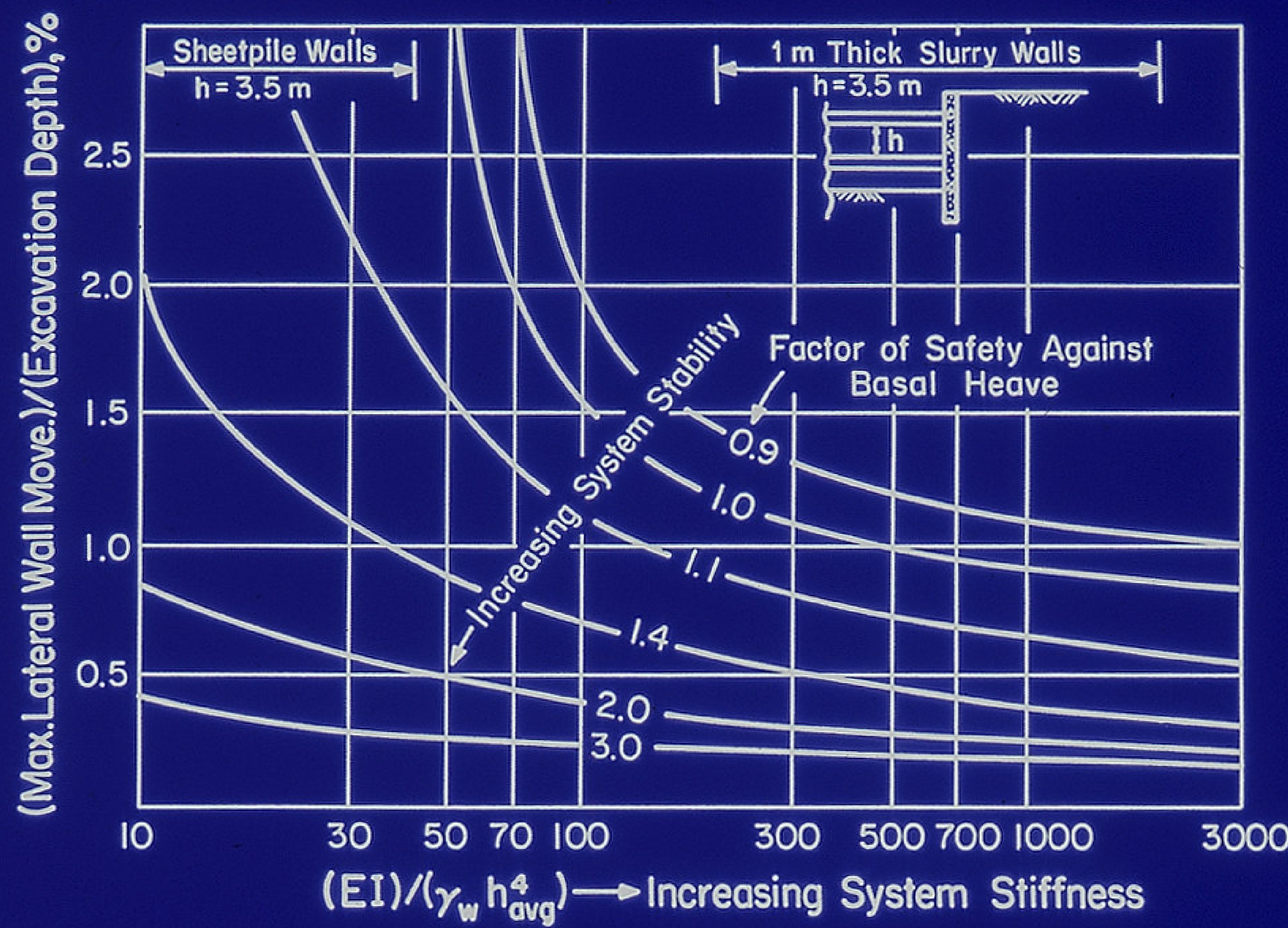
Finite element analysis of walls



U-frame lock

Urban excavation support system

Design chart



The portable HP-9810, introduced in the early 1970s, was the first generation of programmable calculators.

This Commodore Personal Computer, introduced in 1984, had as much as 2 MB of RAM and as much as 200 MB of hard drive storage capacity.

Old-Computers.com

Ed Thelen

The Cray 1 vector supercomputer was introduced in 1975.

By the early 1990s, scalable parallel processors were designed so that their owners could add components to increase their capacity.

Old-Computers.com

Convex C3800

"In the last decade, the power of computation – our ability to model and simulate experiments that we have not conducted in a laboratory – has become so great that it must now be considered a third pillar, along with theory and experiment, in the triad of tools for scientific discovery."

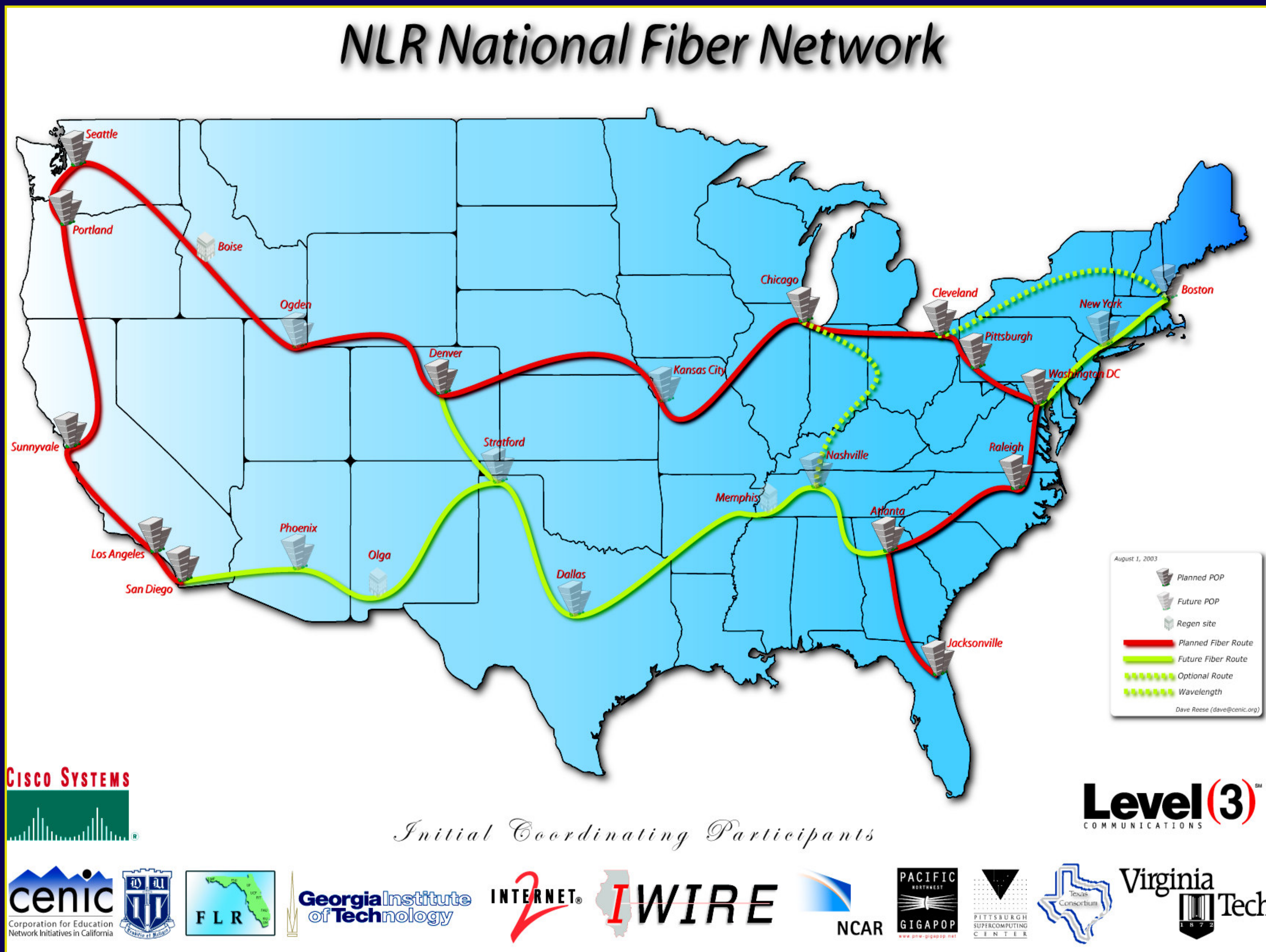
The Challenge and Promise of Scientific Computing
U.S. Department of Energy Office of Science

Georgia Tech's "Razor" weighs 35 tons and has five miles of copper cable attached to it.

Supercomputing power is essential in the emerging field of nanomedicine.

Blue Gene/L (above) at Lawrence Livermore National Lab is the world's most powerful supercomputer. It works in tandem with ASC Purple, right, on simulating nuclear weapons tests.

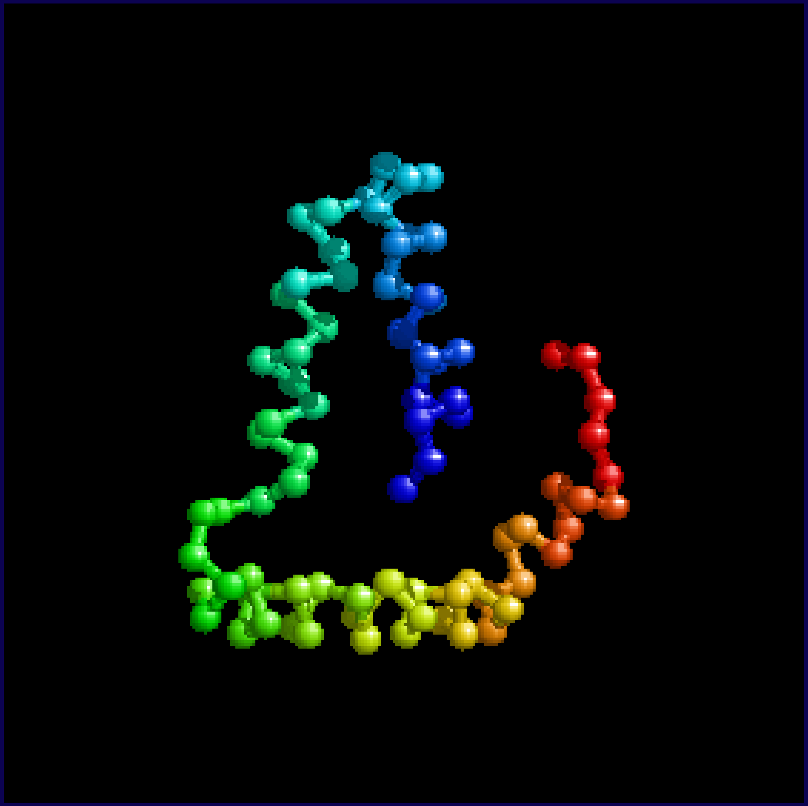
National LambdaRail



10-year Application Goals: DOE's Advanced Scientific Computing Research

- Enable nanoengineering of new materials
- Enable design and engineering of fusion power plants
- Understanding regional impact of global climate change
- Develop bacteria that can produce hydrogen, sequester carbon and clean up toxic waste
- Better understand the fundamental nature of matter
- Understand processes that underpin the combustion of fossil fuels to reduce pollution, increase efficiency

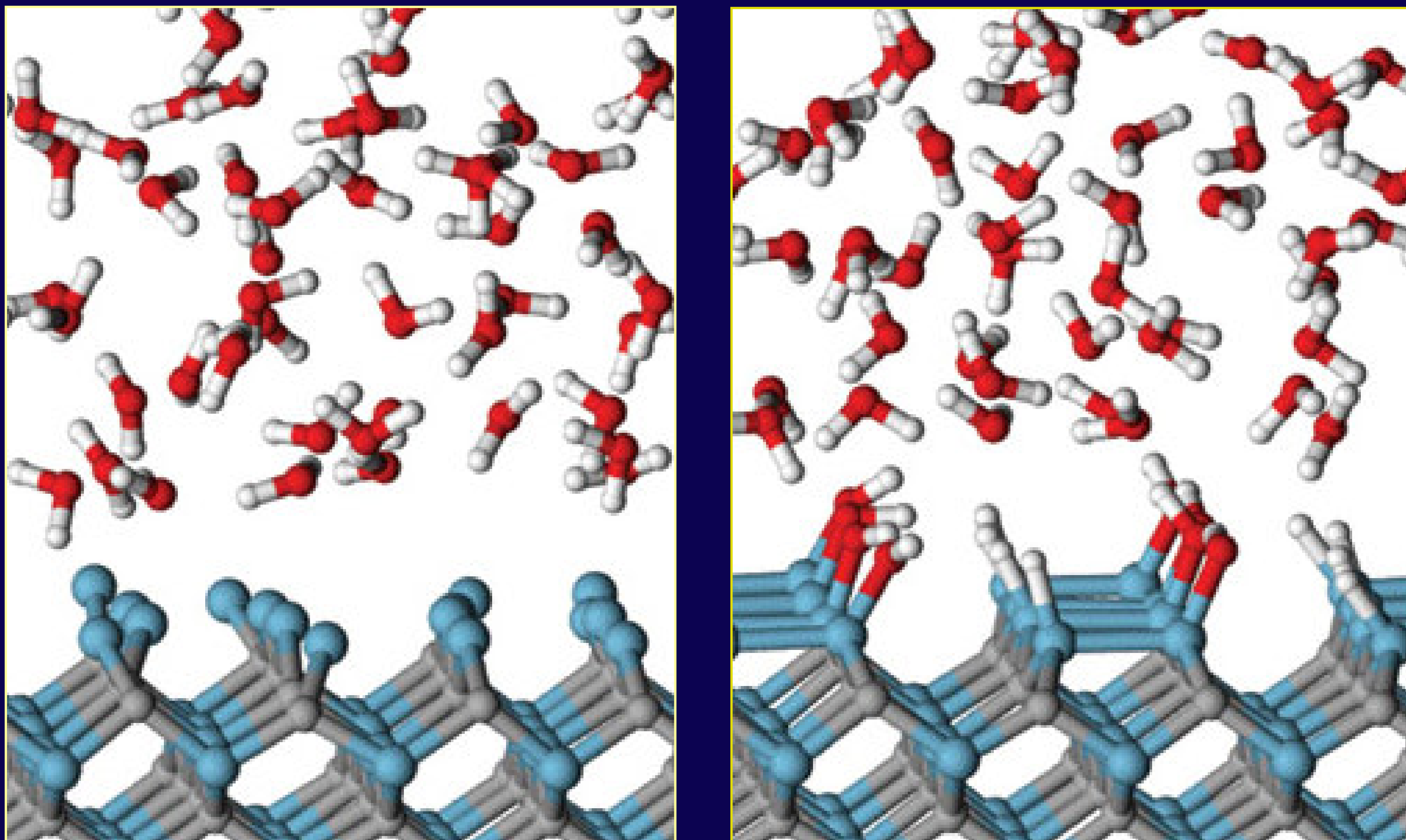
Modeling protein folding



University College London Bioinformatics Unit

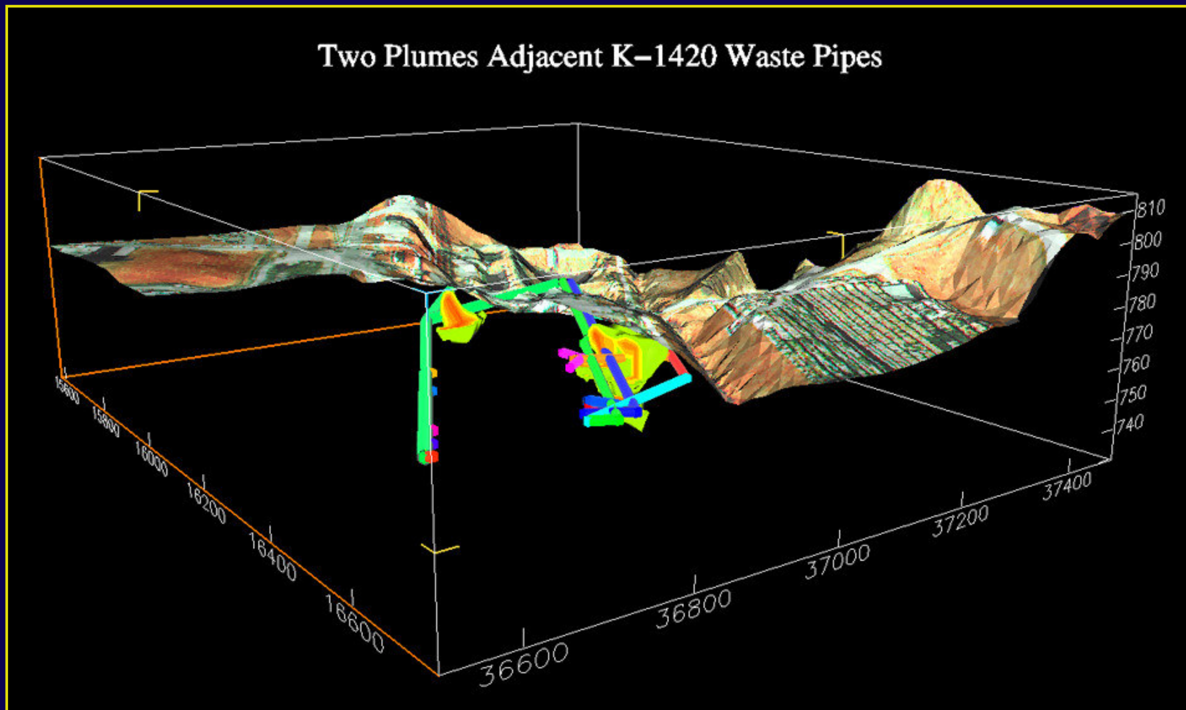
Accurate and reliable protein folding simulation will need the next generation of supercomputers, because of the many complex interacting forces that must be included in the model.

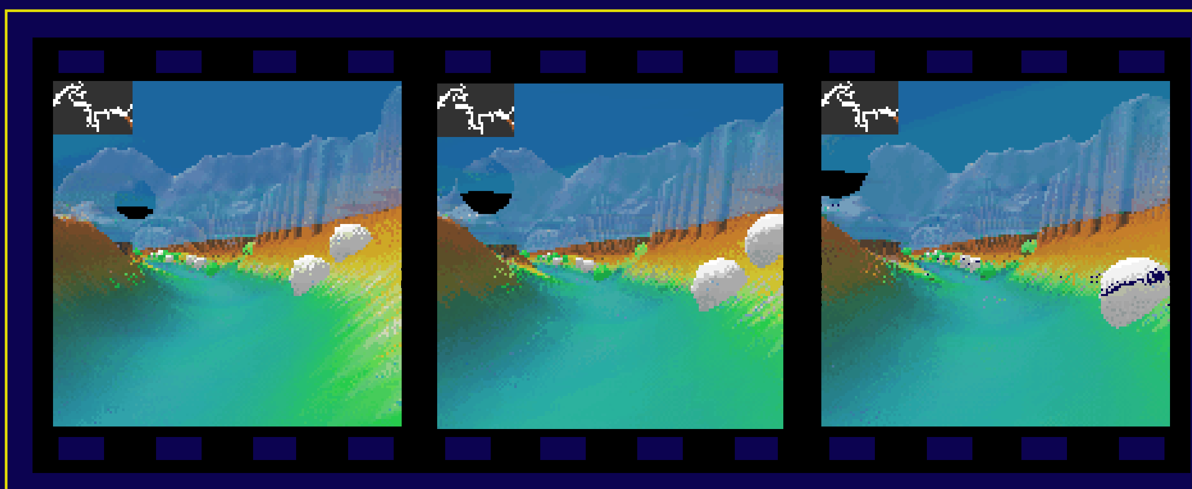
A computer simulation demonstrates how water molecules (red and white) break apart to bond with a layer of silicon carbide that has silicon atoms on the outside.



Lawrence Livermore National Lab

Theoretical physicists use supercomputers to build three-dimensional dynamic simulations of how atoms and molecules of materials interact with each other.

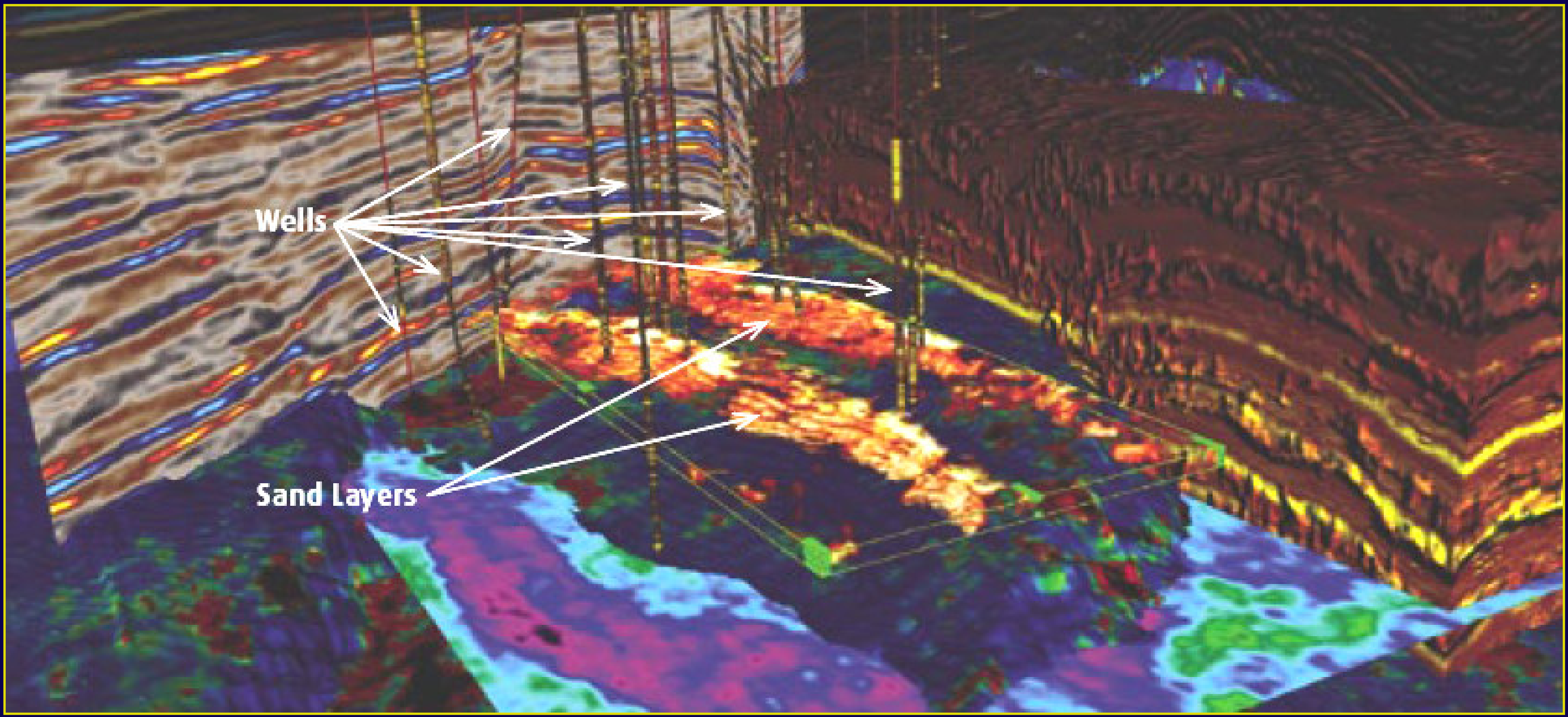




Clinch River visualization

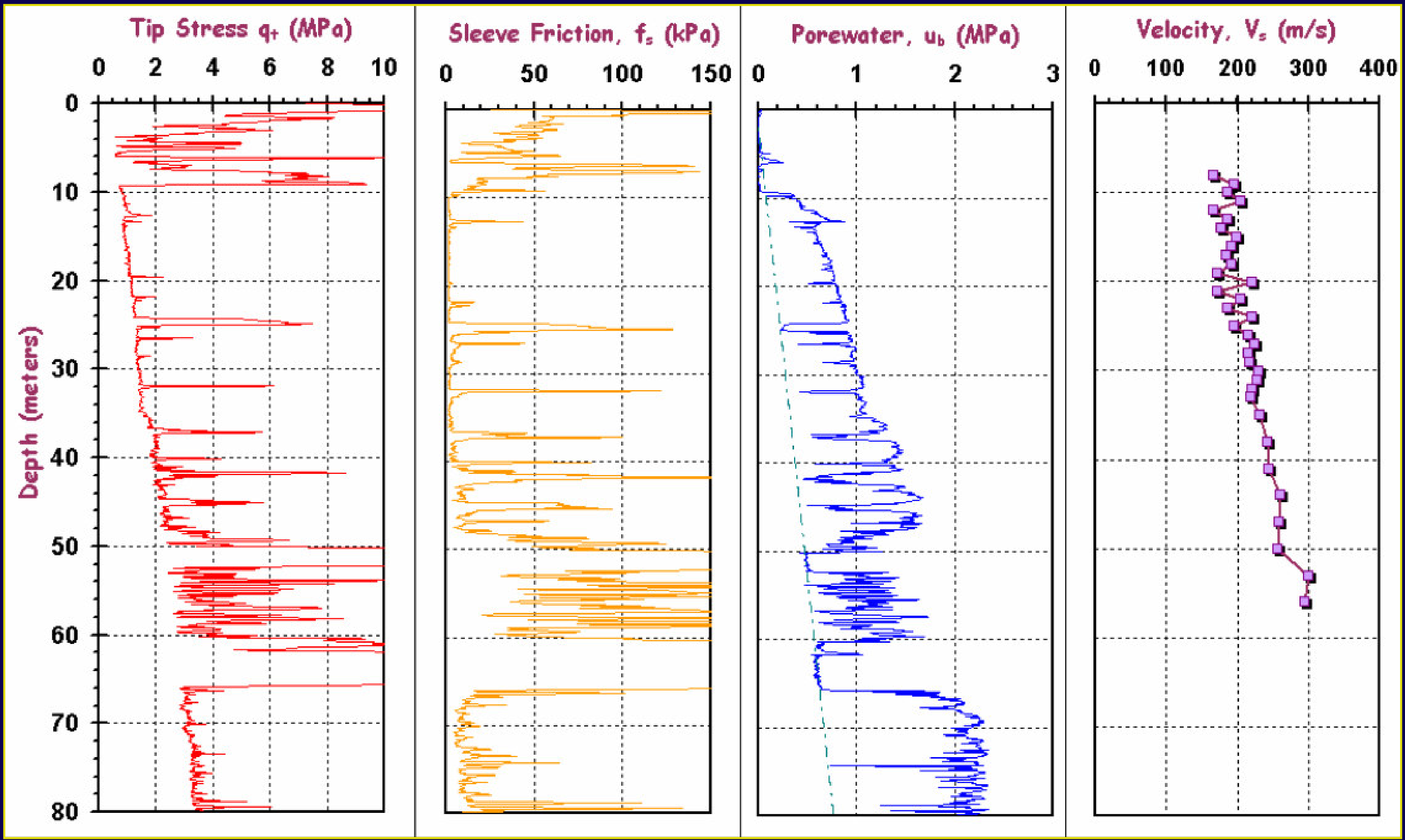
Oak Ridge National Lab's Geographic Information Science and Technology Group develops 3-D terrain visualization images and animated 3-D visualizations.

A supercomputer generated this 3-D image from 6 gigabytes of seismic data generated from several hundred images. The vertical lines indicate oil wells.



Chevron-Texaco Corporation

Seismic piezocone soundings now optimize the subsurface data provided by in situ tests.



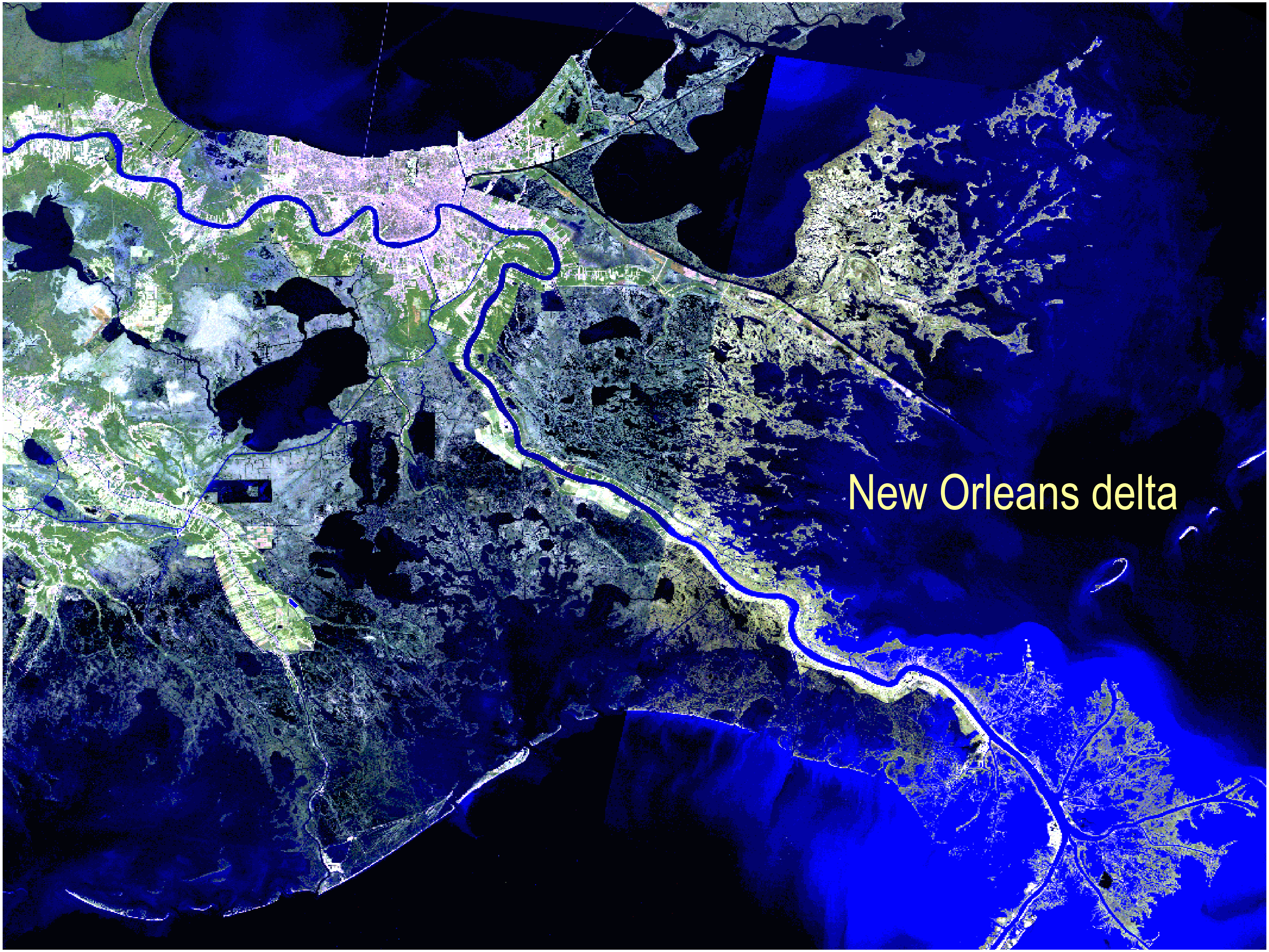
Workers boring the Muni Metro tunnel in San Francisco encountered piles from old piers and the wreckage of sunken ships.

Computer modeling can correlate weather patterns and soil moisture levels…

…helping determine both optimal construction schedules and appropriate materials for roadbeds.

Hurricane Katrina

August 29, 2005


New Orleans delta

Katrina's path

Source: http://flhurricane.com/googlemap

17^{th} Street Canal, looking north

17th Street Canal breach

The breach repaired

Entergy Corporation

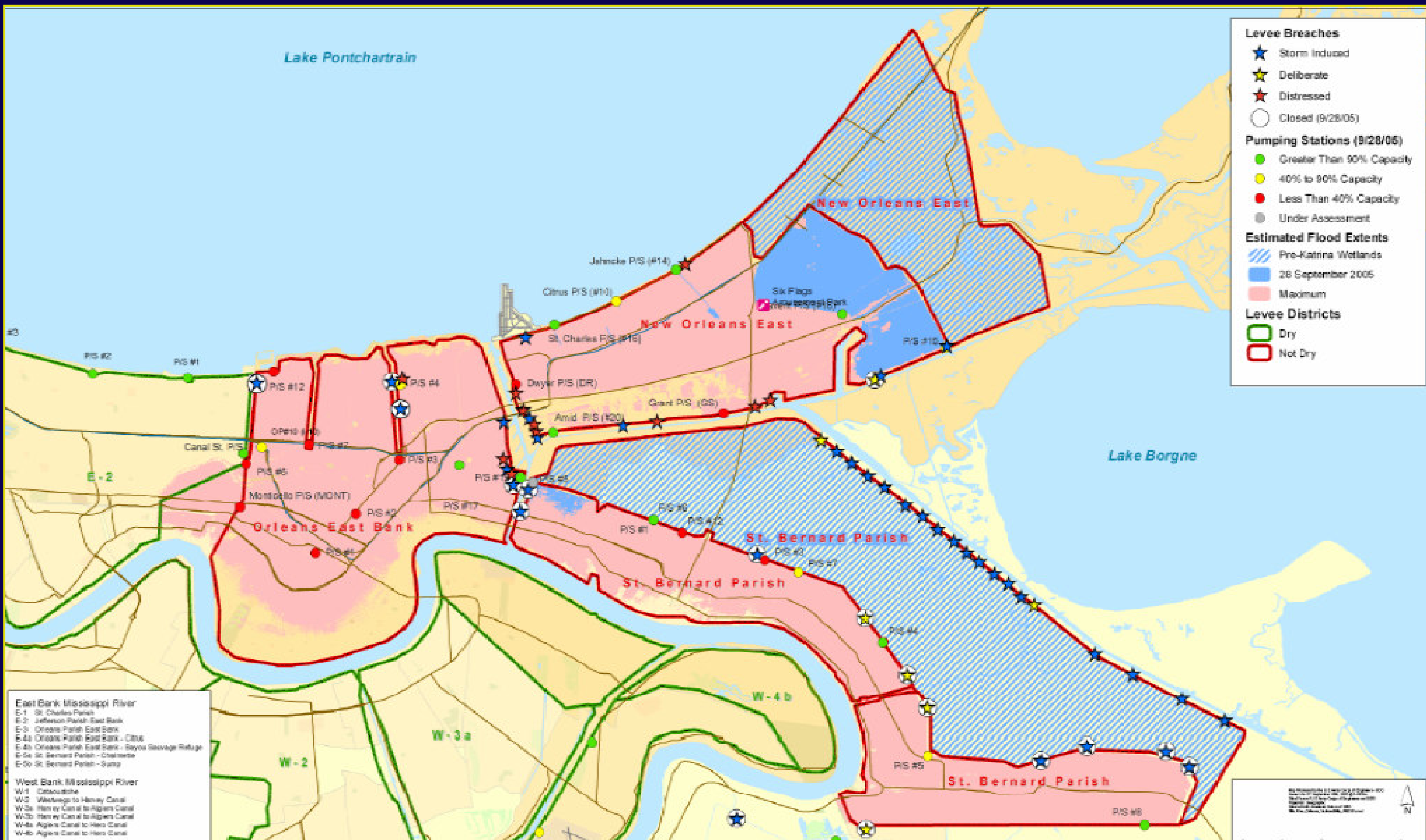
Earthen levee under Rte 47 bridge

The storm surge overtopped the levee, but it emerged largely intact (with some scour).

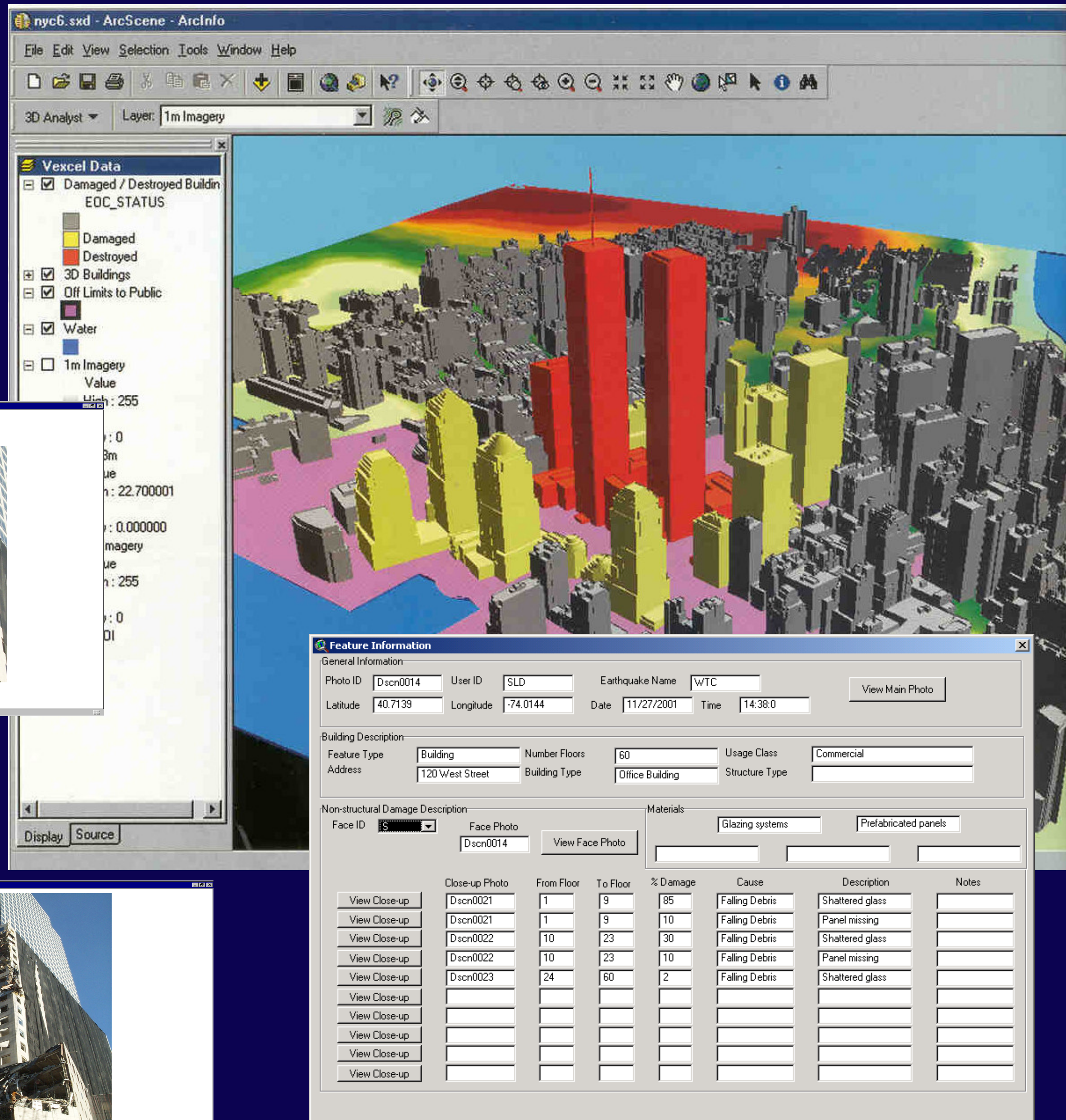
Francisco Silva

New Orleans:

Flooded areas shaded
Breaches indicated with stars



Interactive 3-D GIS Analysis



Systems – according to Webster

"A regularly interacting or interdependent group of items forming a unified whole."

GEOSYSTEMS: What is it?

- Societal, historical, legal, policy framework
- Planning for communications with public
- Understanding of factors that drive decision making
- Context for economics and market issues
- Expectations of stakeholders and who they are
- Geologic and geotechnical aspects
- Alternatives for design and construction
- Scenario-based assessment of outcomes
- Implementation of advanced computational systems